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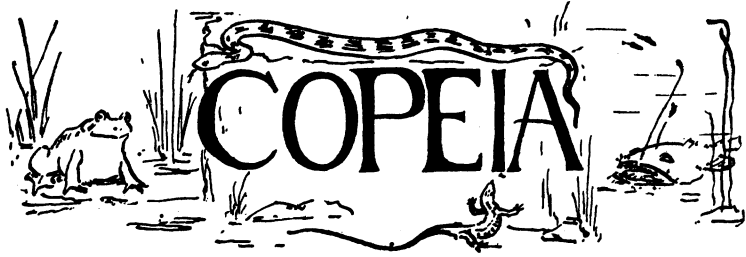
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*Published to advance the Science of cold-blooded vertebrates*

## THE FLIGHT OF THE CALIFORNIA FLYING-FISH (*CYPSELURUS CALIFORNICUS*)

The flight of the fishes of the family *Exocoetidae*, and to a lesser extent that of other groups of flying fishes, have called forth so many published accounts that a considerable volume of literature on the subject has been developed. The discussion has largely been of a controversial nature; the point at issue being, whether the fishes actually fly by flapping their "wings," or merely soar through the air. It is not within the scope of this addition to the discussion, to summarize nor to criticize the statements of the various authors who have written on the flight of fishes. The purpose of the paper is rather to describe in some detail, the flight of a species, *Cypselurus californicus*, which, by reason of its unusually large size, strong flight, abundance, and accessibility, is an exceptionally favorable one for observation.

The details of the flight of *Cypselurus californicus*, never described with sufficient fullness; may readily be observed by a person at the bow of a small vessel plying through the sea off the coast of southern California, during the summer months. Seemingly indifferent to the direction of the wind, and without apparent unison in their flight, these flying fishes

<sup>1</sup> Less detailed descriptions of the flight of this species may be found in Jordan and Evermann (Bull. U. S. Nat. Mus. 47, 1, 1896, p. 730, footnote) and in Dr. Jordan's *Guide to the Study of Fishes* (vol. 1, 1905, p. 157, fig. 119); also in several of Dr. Holder's popular accounts of California fishes.

scatter before the boat, as Dr. Jordan says, like grasshoppers before one walking in a meadow.

They appear never to leap directly into the air, as some species are said to do; but, on emerging from the water with greater or less velocity, they immediately spread their wide pectoral "wings" and move forward on the surface like tiny aeroplanes, for a distance averaging perhaps twenty-five feet. While on the water, their sole source of propulsive power appears to be the normal organ of locomotion in fishes—namely, the tail. The pectoral fins, to be sure, are seen to vibrate, but apparently with neither sufficient amplitude nor velocity to propel the fishes forward on the surface, nor to raise them from the water. The vibration of the "wings," though claimed by some to indicate true flight, seems to be due to the less evident, but still observable shaking of the whole body, which in turn is evidently caused by the rapid side-to-side sweeping of the strengthened lower lobe of the caudal fin. The greatest movement of the "wings" is toward their tips, apparently because the fin is rather flexible distally, and because the amplitude of motion is much increased so far out from the body. The moment the fishes rise into the air, their pectorals are held taut: when viewed from the rear they are seen clear-cut, like knife edges. It is very probable, therefore, that not only while on the surface, but in the air as well, the great pectoral fins (of this species, at least) are not flapping wings, but rather planes of support.

While the flying fishes are attaining on the surface the velocity necessary to carry them soaring away through the air, the ventral fins, also enlarged in *Cypselurus*, remain close-folded against the body. Suddenly they are broadly spread, as elevating planes, and the fish gracefully rises into the air. During the flight the ventrals seem to serve an additional purpose: for, when observed from the advantageous position directly in line with the course of flight, these fins may be seen repeatedly changing their plane,

sometimes independently. Apparently serving thus as stabilizing planes, they seem to keep the course of the fishes through the air rather steady, even in a gale. No such regulatory movement of the pectoral fins is apparent.

The flight of these fishes is often straight in direction, but not invariably so; when well under way it may even become semi-circular. The turning is apparently accomplished by the tail and tail fin, which are seen bent in the direction toward which the course is being altered.

During their flight, the fishes seldom rise higher than about five feet (though they may be farther above the trough of the swells), except when forced upward by a gust of wind. The length of the initial flight, unless following a very poor start, varies usually between fifty and three hundred feet; but when flying with the wind, distances of about a quarter mile in the air are occasionally made.

While in the air, the body appears to be arched upward, and the tail is held lower than the head. As the flight reaches its end, the force of gravity having gradually overcome the upward thrust of air-pressure against the pectoral planes, the lower caudal lobe strikes the water first, and the ventral fins are folded. The fishes now either suddenly end their flight, or continue it, they being in the same position as when they first came to the surface. The second flight is a repetition of the first. The necessary velocity to propel them through the air is again attained on the surface by the rapid movement of the tail, which begins as soon as the caudal fin touches the water. Two or three successive flights are frequently made, and occasionally four, or even five, are undertaken before the fishes finally sink beneath the surface. Usually the flights are of increasingly shorter distance and duration; at the end of the last the pectoral fins, as well as the ventrals, are instantly folded, and the fishes drop into the water with a splash. They light in a horizontal position, ready for their dashing

movements which are seen for a second under the surface.

Owing to the greater resistance offered by the water, changes in the direction of movement are much more swiftly accomplished in that medium than in the air. Sometimes they soar straight toward the side of a vessel, until they seem about to crush themselves. But they suddenly plunge into the water, twist directly backward in their course within a radius of about ten feet, and make away in the opposite direction, either in the water or in the air.

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### HIBERNATING TOADS ON LONG ISLAND

On March 23, 1908, in plowing a garden plot of about one-eighth acre, nine adult toads, *Bufo fowleri*, were exposed. These were all at a uniform depth of six inches. All were inclosed in an oval-shaped chamber slightly larger than the batrachian, the walls being hard and smooth. The plow being set at a depth of six inches, all the toads were badly mutilated and in every case the body exploded with a loud report as the point of the plow-share entered it. This plot was fallow ground, no sod or rubbish covered the surface soil.

Occasionally in other springs while early plowing, toads are turned out at this depth. The writer has record of them hibernating at a depth of eight to twelve inches in Orient.

On January 19, 1910, in turning over a board in the garden a large toad was found underneath. It was tucked down in a depression in the soil and the only covering above was the board seven-eighths inches thick.

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